A STUDY PLAN AND AN APPROXIMATE ESTIMATE OF THE COST OF A GRAVITY YARD

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

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ENTITLED A STUDY PLAN AND AN APPROXIMATE ESTIMATE OF THE COST OF A GRAVITY YARD

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF Bachelor of Science

Railway Civil Engineering

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In order to intelligently design a railway yard or cluster all possible information must be obtained on several points. These may be classed as follows:-

1 What is the purpose of the cluster?

2 How many cars per day must be handled?

  a At present.
  b In the future.

3 What kind of freight?

  a Ratio of the different classes of freight.

4 What local shippers must be reached?

5 What right of way is available?

6 What is the character of the surface of the ground?

7 What yards are required to care for the traffic?

8 What method of switching will be used?

9 What spacing will be used for the body tracks?

These will be assumed as follows:-

1 A general yard at a division terminal.

2_a Forty daily trains averaging fifty cars each.

2_b Eighty daily trains averaging fifty cars each.

3 General freight, both through and local.

4 Local shippers not served by the freight house and requiring spur tracks will not affect the general lay-out of the yards, so will not be considered.

5 The yards are supposed to be located so as to readily obtain all necessary right of way.

6 The ground is taken as level and the grade of the main tracks considered as datum.

7 The cluster is composed of a receiving, classification, forwarding, and caboose yard for each line of traffic; with storage, engine, repair, and construction yards of sufficient capacity to serve both lines.

8 Tail switching will be used except between the receiving and classification yards, where humps will be placed. All switches will be thrown by hand.

9 Body tracks will be spaced 13 feet center to center; open and running tracks, 15 feet center to center; and a minimum distance of 20 feet for the main tracks.

Having determined the general character of the yard, we will take up its parts in detail.

Lead Tracks:-

A long train entering the receiving yard should be able to clear the main track before any delay or stoppage is caused by the shifting movements in the cluster. For this purpose a special track should be provided as long or longer than the maximum train. A train of sixty cars would require 2,400 feet and stopping room, so 3,600 feet will be chosen, as this will give room for a maximum train and a short drill for a shifting engine. A freight train on level ground with 3,000 feet or more in which to stop should take the turnout at high speed, so a No. 16 frog will be used for both lead tracks.

Receiving Yards:-

A switching crew will require practically 25 minutes for a train of fifty cars, to allow for delays say 30 minutes per train; a small accident might easily delay the work for one hour, in which time six trains could enter the yard. This will make a temporary storage imperative, and in view of such an emergency seven tracks will be provided of 3,600 feet clearance, being capable of holding a seventy to eighty-car train with stopping room. These tracks are placed for convenience on a single ladder, making the frog angle with the body tracks. The minimum distance, M, for a No. 8 frog, such as will be used at all yard switches, is the distance from the point of switch to the frog point plus the distance from the frog point to such a point that ordinary ties under the main track and the turnout will not overlap, or $M = L + N(T - G)$. This will be when the center lines of the tracks are T feet apart where T equals the length of the tie, L the lead, N the number of the frog, and G the gauge. Also, M must not be greater than $\frac{P}{\sin F}$, where P equals the distance between the center lines of the body tracks and M is the minimum distance between the frog points on the ladder. M for a No. 8 frog is 98.4 feet, while $\frac{P}{\sin F}$ is 104.4 feet. The body tracks being at the frog angle with the ladder, no saving is made in reducing the frog distance to less than 104.4 feet, so this will be the distance between frogs.

The farther end of the tracks in this yard is on a +0.5 per cent grade to assist in stopping the train as well as

to save some work for the shifting engine.

Hump Tracks:-

A rise of 0.5 per cent begins 1,000 feet before the extreme end of the receiving yard is reached, so the hump track really starts from an elevation of +5 feet. This +0.5 per cent grade continues for 800 feet more where it is displaced by a + 1.0 per cent grade to the summit, 800 feet away. At this point the grade changes to a -1.0 per cent for 50 feet, then -0.5 per cent for 50 feet, while passing over an automatic scale. Then comes a drop of -2.0 per cent for 200 feet, in order to give distance between cuts, then -1.0 per cent for 500 feet, after which comes a -0.4 per cent to datum.

Assuming the car to weigh 75 tons when fully loaded, with an average friction of 8 pounds per ton, curve compensation 0.44, and solving for V in $V = \sqrt{64.32\ h}$, we find the following velocities:-

At the end of the first	50 feet	3.00	miles per	hour
" " " " " second	50 "	4.22	" "	"
" " " " " first	300 "	13.90	" "	"
" " " " " next	500 "	23.70	" "	"

From this time on the velocity will decrease to 12 miles per hour, after which it will remain constant. This gives a prohibitive velocity, requiring brakes soon after leaving the -3.0 per cent grade, but the conditions under which these velocities were figured are those found in warm weather, when journal friction is small. In zero weather a very different coeffi-

cient of friction must be chosen, over 12 pounds per ton being common where cars have been standing for some time, and this would give the following velocities:-

At the end of the first	50	feet	2.44	miles per hour
" " " " " second	50	"	1.02	" " "
" " " " " first	300	"	10.15	" " "
" " " " " next	500	"	15.65	" " "

These values are not too large for quick work, so since it is better to have the yard capable of work in all kinds of weather, the grades will be left as above, too steep for summer work without the use of brakes.

Classification Yards:-

The classification yard begins just past the automatic scales. The ladder track is set at twice the frog angle in order to economise space. The body tracks are in sets of three, there being three body tracks to each frog on the ladder. The first set of tracks is brought out from the lead track, as it could not be connected with the ladder without materially increasing the spacing between the first and second tracks. The arrangement and distances of this part of the yard are shown on the accompanying blue print.

The body tracks of this yard are but 1,400 feet in the clear with a safe capacity of about 30 cars each. The present plan includes 19 body and 1 open track, with room for an addition of 21 body tracks, the ladder being so arranged as to permit two trains to be switched at the same time.

Forwarding Yards:-

The forwarding yards are similar to the receiving yards in size and construction, the only difference of importance being that the grade is 0.0 throughout.

Advance Tracks:-

The advance tracks are two in number, one for each line of traffic, and are in all respects similar to the lead tracks.

In addition to these yards and tracks used for through traffic, some accommodation must be provided for local traffic. This requires three sets of tracks or yards: company coal for locomotives, storage, and freight house.

Coal Yard:-

This yard is intended not only to hold cars loaded with company coal, but also as a temporary storage to hold local cars until such time as the yard engines can conveniently transfer them to their proper location.

Freight House Tracks:-

These tracks are intended to serve the freight house and wagon and transfer platforms.

Storage Yard:-

No matter what the rush for cars nor the importance of quick freight handling, the company will be required to hold a large number of cars awaiting orders of the consignees, and must have a special place for them in order to keep the working tracks clear. In seasons of slack business, also, extra storage room may be needed, so we have provided 7 tracks with a capacity of

60 cars each, while there is room for additional storage of 3,500 cars.

Caboose Tracks:-

Forty daily trains means forty cabooses. The law requires a crew to lay over at least ten hours, say an average of twelve hours for all crews. In this time 20 or even 30 trains, - counting extras, - may have come in, so ample provision must be made for at least 30 cabooses at each end of the cluster. Assuming all cabooses to be large ones, at least 1,100 feet of track must be provided. The arrangement of these tracks is such as to be easily accessible for the switching engine for one yard and in the other the cabooses are placed by gravity. Both of them are specially designed for the road crew to get out their own caboose when starting on their run.

Engines:-

The same quantities affecting caboose will affect engine facilities; now if we run all engines to one roundhouse we should have stalls for 60 engines. A roundhouse of 150 feet radius, inside diameter, will give three open tracks, roundhouse foreman's office, and 60 stalls. At even the best regulated roundhouse some storage or standing tracks are necessary, so ample room is provided for these in close proximity to coal, water, and the cinder pits, while opening directly on the running tracks.

Repair Tracks:-

These are eight in number, four of them being strictly outside and four being covered at one end for indoor work. These

are intended to make all running and light repairs, while cars needing thorough overhauling and reconstruction will be taken to the "shops" at the other end of the cluster, where plenty of yard and house room is provided.

Shops:-

The accommodations prepared for car building consist of a large material yard, by the side of which is located a wood shop, construction shop, paint shop, glass shop, and necessary yard room. The engine shops are located near the roundhouse, so as to be convenient to disabled locomotives as soon as they have been dumped and cleaned. They consist of a large boiler room, machine room, forge room, and a foundry, while they are also conveniently located with respect to the wood shop and the material yard. The power house is so located that all fuel needed for power as well as the forge and foundry may be kept in one locality. The general office stands aloof, and yet occupies a central position.

After having decided on the size and arrangement of the yards, and after having drawn plans and profiles to scale, the next thing is to determine the various quantities and their costs.

The cost of construction is naturally divided into five classes:-

1 Cost of right of way.

2 Labor, including engineering, supervision, and work of track laying.

3 Grading, including in this cluster, only the humps.

4 Materials, including ballast, ties, rails and fastenings, turnouts and crossovers, fences, cattle guards, and water and air piping.

5 Buildings, including all buildings, coal chutes, scales, water tank, turn table, transfer table, and cinder pits.

These items will now be taken up in the order given:-

1 The land required is 269.74, or 270 acres, and this will cost approximately $200 per acre, or $54,000.

2 The labor for track laying varies in different localities from $200 to $500 per mile of track, supervision and engineering from $40 to $50 per mile of track. As our work will be in one body, we may take $400 per mile as an outside figure for the cluster. The total trackage is 403,000 feet, or 76 1/3 miles, which will cost $30,500 to lay.

3 The grading of this cluster will not be expensive, as the material for the two humps is the only grading required. The total earth required to give two hump tracks and the present yard elevations is 107,417 cubic yards for each hump, or a total of 214,840, say 215,000 cubic yards. The price for grading is from 30 to 50 cents per yard in place, and since this material will have to be obtained outside the yard, probably at some distance, 45 cents per yard will be allowed. This would give $96,750 for grading.

4 The cost of material is composed of several important items.

a_1 Stone ballast for main track, 12 inches under the ties and 10 feet wide on top, will require 31,900

cubic yards at $1.00 per yard in place, or $31,900.

a_2 Cinder ballast in the yards will be 6 inches under the ties, or a total of 150,000 cubic yards at 50 cents per yard in place, making the total cost of ballast $106,900.

b Ties will be 6" x 8" x 8.5', and 233,000 will be required. These will cost 70 cents each in place, or $163,100.

c Rails will be 75# for yard work and 90# for main track, at $20 per ton for second-hand rails and $28 per ton for new rails. We will consider that our road is able to complete the yard with its own second-hand rails, while the two main lines will be of new rails. This gives 8,464 tons of 75# rails at $20 per ton, or $169,280, and 1,580 tons of 90# rail at $28 per ton, or $44,240, making a total expense of $213,520 for rails.

d We will need 3,387 kegs of spikes, 5 1/2"x 9/16", and 23,800 pairs of angle bars with bolts for fastening our track. The cost will be $3.65 per keg for spikes, or $12,363, and $1.20 per pair for angle bars, or $28,560, making a total of $40,923 for fastenings.

e We will need 258 turnouts for a No. 8 frog, which will cost $215 each, or $55,370, 4 No. 16 turnouts at $300 each, or $1,200, and 6 crossovers at $400

each, or $2,400, making a total of $58,970.

f To fence our right of way we will require 3,080 rods of No. 10 woven wire, which will cost 71 cents per rod in place, or $2,185, and 70 rods of strong board fence at the freight house, which will cost $260 more, making a total of $2,445 for fence in place.

g We will consider that we have no road crossings within the limits of the cluster, so no cattle guards will be necessary.

h The water pipe for our engine supply will be 8 inch cast iron pipe 1/2 inch thick, which weighs 44 pounds to the foot. 2,800 feet will be required, which at $35 per ton in place will cost $2,900, and 4 goose-necks at $400 each, complete, will cost $1,600, making a total of $4,500.

i Air will be required in each of the forwarding yards and in the shops. The line pipes will be 3 inches in diameter and we will require a total of 14,000 feet, with 2,000 feet of 2 inch pipe for branches and 200 elbows and stopcocks. These will cost in place approximately $5,000.

5 It is almost impossible to give a fair estimate of the cost of buildings without entering into plans and details of construction. In case of actually building the cluster, a joint estimate of the completed buildings would probably be made by the civil and mechanical departments. A rough estimate may be made,

however, based on the cost of structures now in use.

1 Brick roundhouse, @ $2,550 per stall	$163,000
1 Turntable, 100 ft. deck	6,000
4 Cinder pits, @ $1,875	7,500
1 Coal chute	2,500
1 Oil house, complete	1,000
1 Sand house, complete	780
1 Pump house, complete	1,200
1 Water tank	1,200
4 Track scales, 100 ton, 45 ft.	7,600
Machine, boiler and forge shops, @ 80¢ per sq. ft.	80,000
Transfer table	10,000
Power house, @ 90¢ per sq. ft.	12,000
Foundry, @ 40¢ per sq. ft.	12,000
Wood shop, @ 40¢ per sq. ft.	12,000
Car construction shop, @ 60¢ per sq. ft.	98,000
Paint shop, @ 50¢ per sq. ft.	42,000
Glass shop, @ 50¢ per sq. ft.	3,000
General office, 2 floors, @ 45¢ per foot per floor	55,000
Repair shed, @ 40¢ per sq. ft.	19,000
Small yard buildings, approximately	4,000
This makes a total building item of	$537,780

The total cost of construction of our cluster, therefore, will be the sum of all the previous items, as follows:-

Land	$ 54,000
Grading	96,750
Materials	627,258
Track laying	30,500
Buildings	537,780
Or a total of	$1,286,288

ENLARGED DETAIL OF PART OF THE DOUBLE LADDER OF THE CLASSIFICATION YARD

Scale 1"-20'

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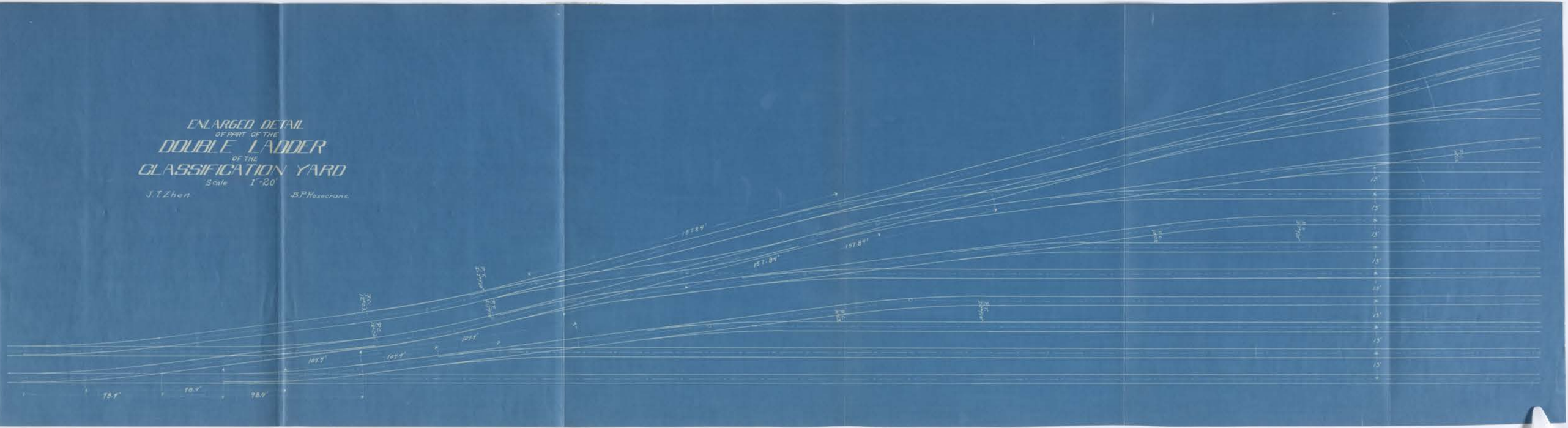
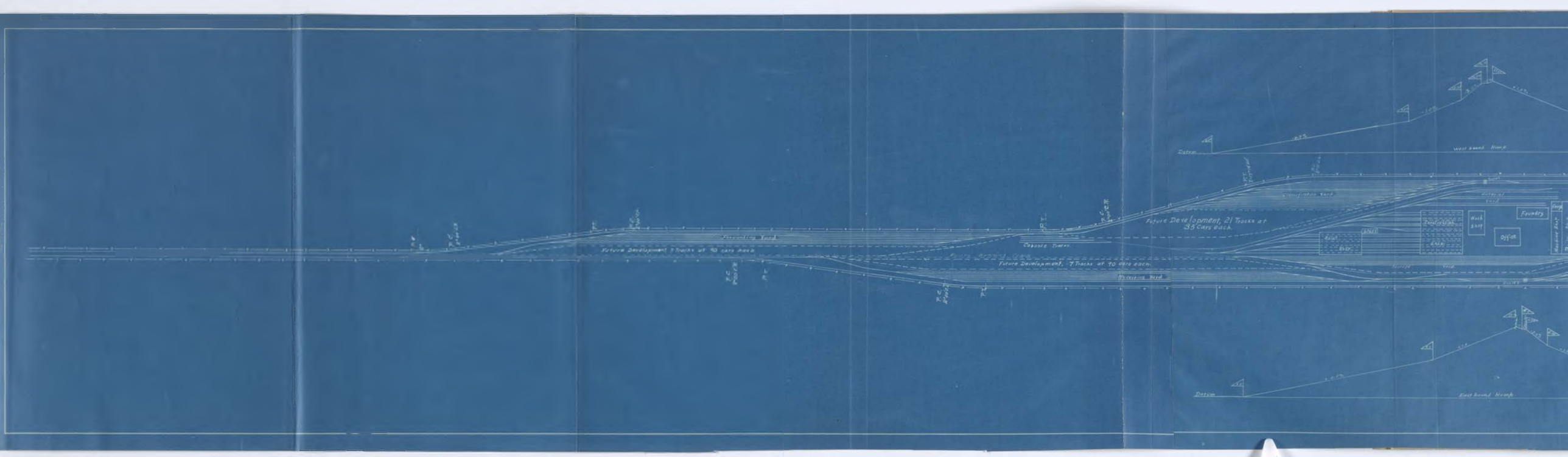
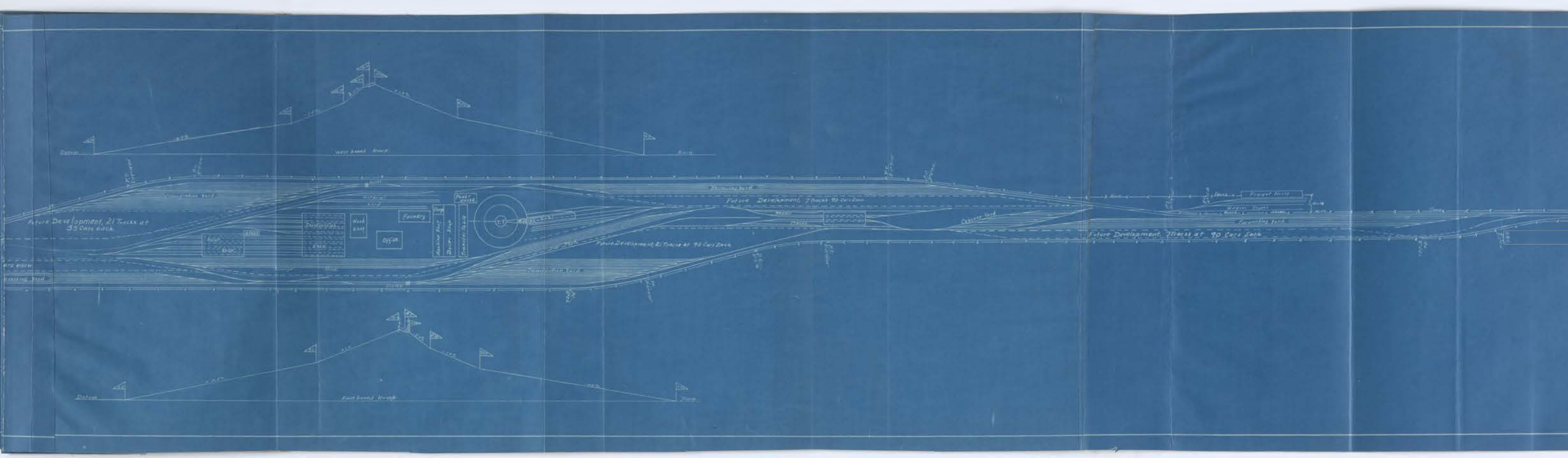



Future Development 7 Tracks at 70 cars each
Receiving Yard
Classification Yard
Future Development, 7 Tracks at 70 cars each
Future Development, 21 Tracks at 35 Cars each
Datum
West bound Hump
Datum
East bound Hump
Foundry
Office


Future Development, 21 Tracks at 35 Cars each.
Future Development, 7 Tracks 90 Cars Each
Future Development, 21 Tracks at 90 Cars Each
Future Development, 7 Tracks at 90 Cars Each
Foundry
Office
Power House
Machine Shop
Blacksmith Shop
Transmission Shop
Passenger Yard
Freight House
Caboose Yard
Receiving Yard
Datum
West Bound Hump
East Bound Hump

GENERAL PLAN OF CLUSTER FOR DIVISION TERMINAL

SCALE

General Plan	1" = 400'
Hump Profile:	
Horizontal	1" = 400'
Vertical	1" = 10'

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